PAY EQUITY
EQUALITY AT WORK

3 INTERPRETATION AND WAGE ADJUSTMENTS

Manitoba
Labour
Pay Equity
Bureau

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3 INTERPRETATION AND WAGE ADJUSTMENTS

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PREFACE

To assist in the process of implementation, The Pay Equity Bureau has prepared educational materials for use by parties affected by The Pay Equity Act.

This booklet is designed to assist in the interpretation of the values of job classes; identification of pay discrepancies between comparable male and female-dominated job classes; determination of necessary adjustments to female-dominated job classes; and negotiation of an acceptable implementation plan.

Hypothetical case studies and illustrations have been used to demonstrate possible situations and alternate ways of correcting inequities. However, it should be noted that circumstances may vary with different organizations. Therefore any analysis and correction of gender-based pay inequities should always be considered within the framework of the legislative parameters of The Pay Equity Act.

Other publications in this series are:

Book 1 - Job Evaluation
Book 2 - Job Analysis

REQUIREMENTS*	Legislative Reference: Direct	Legislative Reference: Indirect
1. The purpose of the Act is to establish the principle of pay equity in Manitoba and to inform employers, unions and employees, in both the public and private sectors, of the principles and practices of pay equity.	Section 2	
2. Pay equity is defined as a compensation practice which is based primarily on the value of the work performed, regardless of the gender of the employee. It includes the requirement that no employer shall establish or maintain a difference between the wages paid to male and female employees, who are performing work of equal or comparable value.	Section 1 - definition of "pay equity"	Section 6(2)
3. Value is assessed using the composite of skill, effort and responsibility normally required in the performance of the work and the conditions under which the work is performed.	Section 6 (1)	Section 6(2)
4. No employee's wages can be reduced to implement pay equity.	Section 7(1); 7(2)	

*The Pay Equity Act, S.M. 1985-86, c. 21. C.C.S.M. c.P.-13.

5. Pay equity is mandatory in the Manitoba Civil Service, Crown corporations, and 27 external agencies comprising 23 hospitals and 4 universities. Under the act, the civil service commenced implementation October 1, 1985, while for the other entities the process began as of October 1, 1986. The external agencies are listed in the Schedule at the end of the Act.	Section 8(1); 13(1) Schedule A	Section 1 - definitions of "Crown entity" and "external agency"; Section 3
6. Other external agencies (such as personal care homes) which receive a substantial portion of their revenue from provincial government funding can be required to implement pay equity by regulation. Local governments and school divisions are not covered by the Act.	Section 1 - definition of "external agency" Section 18 (1); 18(2); 18(3); 18(4); 19(c)	
7. Three features of Manitoba's legislation distinguish it from other existing equal value legislation in Canada: it is pro-active, it makes use of the collective bargaining process, and it calls for the establishment of a Pay Equity Bureau.	Section 8(1); 8(2); 8(3); 13(1); 13(2); 13(3); 5(1)	Section 11; 16; 9(1); 14(1)
8. The pro-active approach obliges the legislated public sector employers to apply a single, gender-neutral, job evaluation system to female-dominated and male-dominated classes of employees in order to compare the value of the work performed. The purpose of the job evaluation process is to identify pay inequities.	Section 9(1); 14(1)	

9. A class is considered gender-dominated if 70% or more of those in a class of 10 or more people are of the same gender. In the case of employers with more than 500 employees, other classes may be considered gender-dominated if negotiated by the bargaining parties involved.	Section 1 - definitions of "female-dominated class" and "male-dominated class"	
10. Through the collective bargaining process required by the Act, employees play a vitally important role in the implementation of pay equity. Unions, representatives of non-unionized employees, and the employer are obliged to bargain in good faith, making every reasonable effort to reach agreements respecting this process.	Section 8(2); 8(3); 13(2); 13(3)	Section 1 - definition of "employee representative"
11. A Pay Equity Bureau has been established in Manitoba Labour, managed by an executive director with broad powers to monitor compliance with the legislation. Public sector employers must file reports with the bureau. These reports will be summarized in the executive director's annual report, which is to be tabled by the Minister responsible in the Legislature. Should the bargaining process break down, the executive director will also have the right to refer unresolved matters to adjudication.	Section 5(1);5(2);5(3); 9(2); 14(2); 5(2)(c); 5(4); 10(2); 10(3); 15(2); 15(3)	Section 10(3); 15(3)

12. In addition to these important monitoring and reporting functions, the bureau also has a mandate to provide pay equity information and assistance to employers, employees, and bargaining agents, in the public and private sectors.	Section 5(3)(a)	Section 5(2)(a); 2(b)
13. A pay equity commissioner was designated to oversee the day to day details of implementation within the civil service, while the Act provides that the other entities may designate a person as pay equity officer to perform a similar role for those organizations. The pay equity commissioner and any appointed officers are obliged to co-operate with the executive director of the Pay Equity Bureau so that the executive director can effectively monitor progress and provide any needed assistance.	Section 12(1); 12(2); 17(1); 17(2)	
14. The Act contains specific deadlines for reaching agreements. In the provincial civil service, implementation began on October 1, 1985. An agreement respecting the development or selection and application of a job evaluation system was to be reached by June 30, 1986. Crowns, designated hospitals and universities began the process October 1986 and had until June 30, 1987 to complete this stage.	Section 8(1); 9(1); 13(1); 14(1)	

15. Once job evaluation is completed, a second round of negotiations deals with the exact allocation and phasing-in of necessary wage adjustments. This second agreement was reached September 30, 1987 by the civil service, while the other entities were scheduled for completion by September 30, 1988. Wage adjustments follow completion of this stage.	Section 9(1); 14(1)	
16. Impasses in the civil service could be referred to an arbitration board. The other entities could be referred to the Labour Board for adjudication.	Section 10(1) through to 10(9); 15(1) through to 15(8)	
17. Pay equity wage adjustments may be phased in over 4 years, following completion of the second agreement.	Section 7(3)(b); 9(1); 14(1)	Section 1- definition of "wages"
18. In any twelve-month period, however, no employer is obliged to allocate more than 1% of the previous year's payroll for pay equity wage adjustments.	Section7(3)(a)	
19. Although the Act makes provision for regulations, to date* no regulations have been enacted.	Section 19	
20. Nothing in this Act affects the existing obligations of employers or the rights of employees under the "equal pay for equal work" provisions of The Employment Standards Act.	Section 4(2)	

***January 1988**

STANDARDIZATION OF PAY RATES FOR PAY EQUITY COMPARISONS

Accurate comparisons between male and female-dominated job classes in an organization and the resulting correction of identified pay discrepancies can only be achieved if the pay rates are standardized to the same baseline level.

Pay rates within an organization may vary as a result of factors such as:

Salaried versus hourly-paid employees

Employees in technical and professional job classes are usually paid on a salaried or monthly basis while workers in trade and clerical classes are paid on an hourly basis. For pay equity purposes, these rates should always be standardized to the lowest possible level, usually an hourly rate.

Length of work week

Employees' work weeks can vary depending on the type of work. For example, office workers may work 37 hours per week while workers in trade occupations work 40 hours per week. If this situation occurs in an organization, the rate should be reduced to an hourly rate for comparison purposes.

Commissions, bonuses, merit adjustments and benefit packages

There may be differences in the compensation policies and practices among job classes in an organization. For example, employees working in sales may be compensated on a base rate plus commission. Employees working as managers often may be compensated not only by salary but also by bonuses and benefits packages. These types of compensation should all be examined within the context of the pay equity exercise. If an economic reward is an integral part of the pay structure for an evaluated female or male-dominated job class, it should be included as part of the pay rate.

Wage progression scales

Many compensation systems have wage progression scales. The range of pay for a job class may be divided into a series of steps usually based on factors such as merit or the period of time to gain proficiency in the job.

Different types of jobs in an organization may have varying numbers of steps in a pay range. Often, trade positions which are traditionally male-dominated have only one or two steps while office p sitions such as clerical have five to six steps in the pay range.

For pay equity purposes, the pay rate level selected for comparison of male and female-dominated job classes should be standardized. There should be a careful assessment of what level would be most appropriate for this comparison. When considering what level is appropriate, factors such as the number of incumbents at each step and the differentials between base rates, mid-points and job maximum should be assessed. Depending on the circumstances in an organization, either base rate, mid-point or job maximum could be used as an acceptable pay rate for comparison purposes in a pay equity exercise.

The following sections of this booklet present the basics on developing graphic perspectives of the evaluated job classes, case studies of possible situations and four of the more common statistical techniques for correcting pay inequities for undervalued, female-dominated classes. However, circumstances may vary with different organizations. Therefore any analysis and resulting correction of pay inequities should always be considered within the legislative framework of The Pay Equity Act.

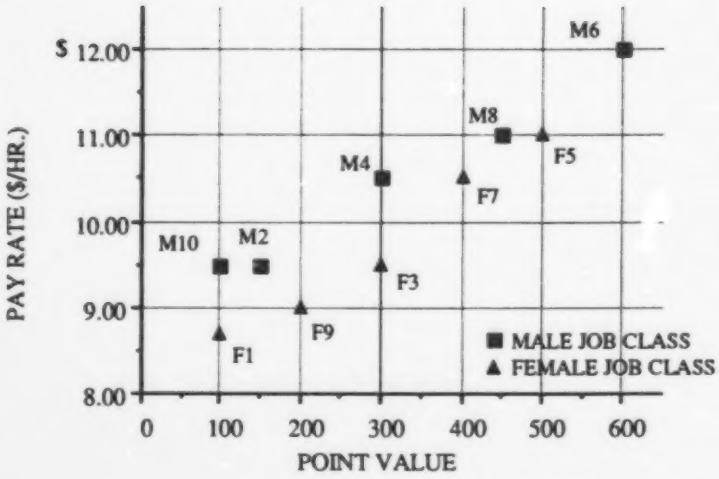
1. Graphic Perspective of Male and Female-Dominated Job Classes

In order to meet the legislated requirements of The Pay Equity Act, the job evaluation system agreed to by the parties must assess four factors: skill, effort, responsibility and working conditions. The most commonly used quantitative systems, such as point factor, produce a numerical value for each evaluated job class which is the composite total for these four factors.

The following example presents a data set and scattergram for evaluated, gender-dominated, job classes in an organization. For more detail on how to create graphs of male and female pay structures, refer to Appendix A.

Gender-Dominated Job Class		Point Values ("x" axis)	Pay Rate ("y" axis)
Male 2	(M2)	150	$ 9.50/hour
Male 4	(M4)	300	10.50
Male 6	(M6)	600	12.00
Male 8	(M8)	450	11.00
Male 10	(M10)	100	9.50
Female 1	(F1)	100	8.70
Female 3	(F3)	300	9.50
Female 5	(F5)	500	11.00
Female 7	(F7)	400	10.50
Female 9	(F9)	200	9.00

FIGURE 1



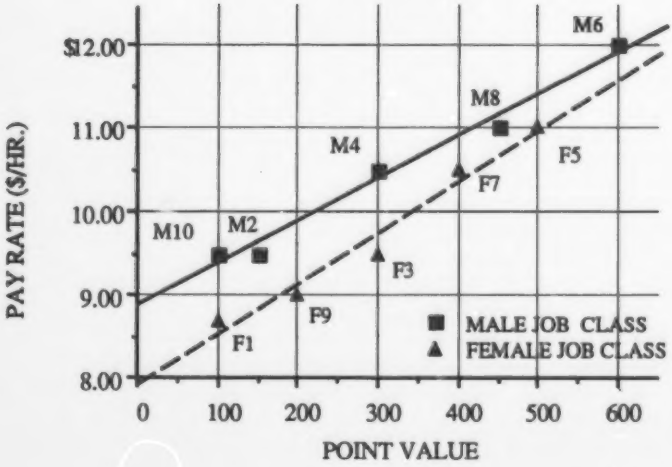
Source: Manitoba Pay Equity Bureau

2. Determination of Wage Regression Lines for Gender-Dominated Job Classes

After a scattergram depicting the male and female-dominated job classes in graphic form is created, the next stage of analysis involves determining the regression lines for each gender. The regression line is determined statistically using the method of Least Squares. For a detailed explanation of this statistical procedure, refer to Appendix B.

The purpose of this statistical procedure is to find the line of best fit for a set of points. In the following example, regression lines have been determined for both male and female-dominated job classes using the same data set as outlined in Section 1, page 3.

FIGURE 2



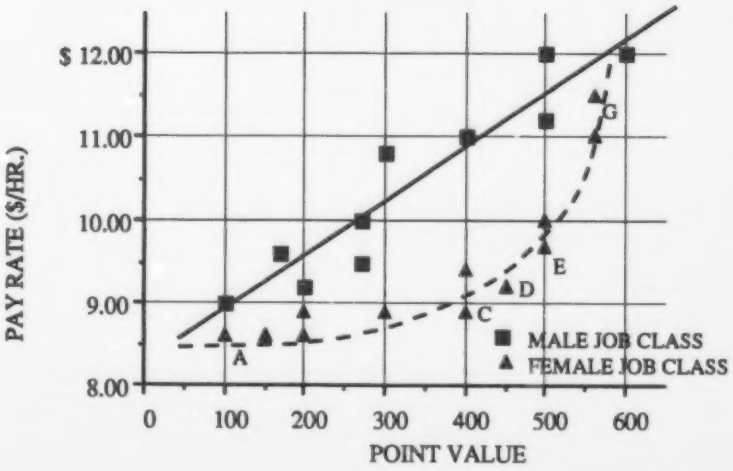
Source: Manitoba Pay Equity Bureau

3. Case Studies of Pay Structures of Male and Female-Dominated Job Classes

In the process of analyzing the pay structures of male and female-dominated job classes, many different situations may become evident. The following examples outline three of the more common cases.

A. Line of best fit not being straight or linear

FIGURE 3



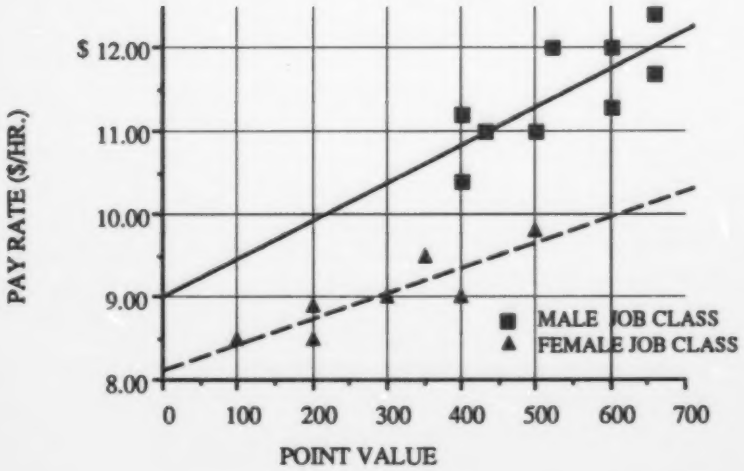
Source: Manitoba Pay Equity Bureau

If the scattergram is drawn before proceeding with further analysis, relationships other than linear or straight may become apparent. In the example given above, the scattergram displays a curvilinear relationship for the female-dominated job classes. That is, the line of best fit is not straight but curved. The female classes C, D and E in the middle of the line are much farther from the male job classes than the classes A and G at the bottom and top of the line. This indicates greater pay discrepancies based on gender in the middle of the range than at either end of the pay structure.

Other situations could involve a male curvilinear line or both male and female lines being curvilinear.

B. Lack of male comparability at certain points on the female regression line

FIGURE 4



Source: Manitoba Pay Equity Bureau

Some organizations may not have sufficient male-dominated job classes scattered throughout the range to allow a comparison to the female-dominated job classes.

This situation may occur due to factors such as:

-The women in an organization being in fewer job classes than men with a higher density or number of incumbents in each class. For example, in an organization with 100 female employees and 100 male employees, the females may be grouped into 10 job classes, with 10 employees per class while the males are grouped into 20 job classes with 5 employees per class. In addition, male workers are far more likely than females to have single incumbent positions in an organization.

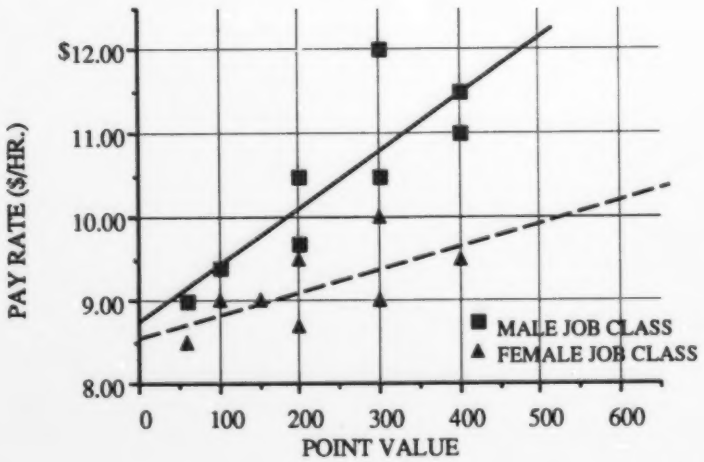
-The men in an organization being far more likely than women to be in higher level, higher paid positions such as management. In the preceding example, the scattergram for males reveals more job classes with

higher point values and higher pay rates than the scattergram for females. This indicates gender-based wage discrimination based on lack of hiring or promotion of females to higher level positions in a company.

If this situation becomes apparent in analyzing data for pay equity purposes, projection of a male regression line could be considered since section 6(2) of The Pay Equity Act refers to projected average schedule or grade of pay. However, caution should be used when projecting a line since if it is projected without supporting evidence, it may be unreliable.

C. The slopes of the male and female regression lines vary

FIGURE 5



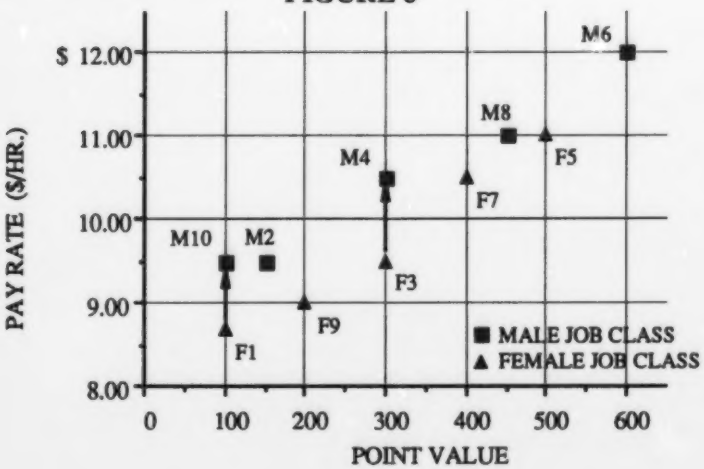
Source: Manitoba Pay Equity Bureau

In this case, the slopes of the male and female regression lines are different. The example given above shows a situation where the males receive increasingly more dollars per point than the females with the result that the inequity in the female pay structure is significantly larger at the top than at the bottom of the line.

In the following section, four of the more common methods of identifying gender-based pay inequities are presented. The selection of an appropriate technique for this stage of analysis in the pay equity exercise is dependent on a number of factors such as the number of gender-dominated classes for comparison, the male and female regression lines, and possible male-dominated job class anomalies.

A. Comparison of Single, Female-Dominated Job Class to Single, Male-Dominated Job Class

FIGURE 6



Source: Manitoba Pay Equity Bureau

One method of correcting inequities is the direct comparison of a single, female-dominated job class to a single, male-dominated job class. This example has used the data set outlined in Section 1, page 3. In this example, female job class 1 has the numerical point value of 100 which is the same

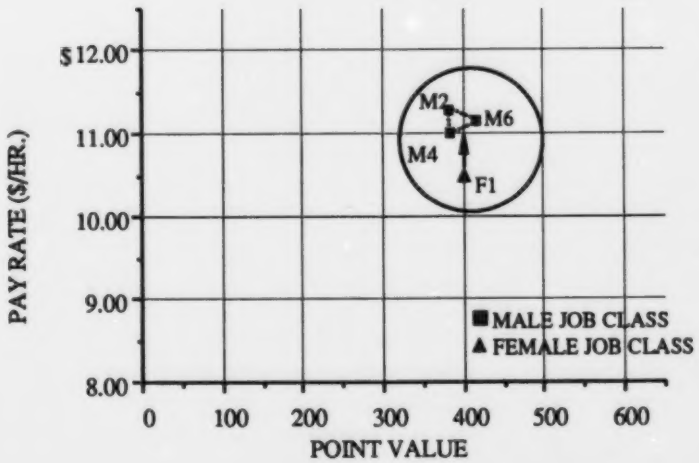
as the male job class 10. Therefore, the pay rate for F1 could be increased from $8.70 per hour to $9.50 per hour. In addition, class F3 has the numerical point value of 300, the same as class M4. The pay rate for F3 could be adjusted from $9.50 per hour to $10.50 per hour.

This technique, although sometimes applicable to specific circumstances within an organization, can have or may result in difficulties such as:

- Lack of male job classes within an organization which have identical point values to female job classes. For example, female job classes F5, F7 and F9 do not have any male job classes with identical point value for comparison; and
- The increasing of the pay rate of a female job class to the level of a male job class which is an anomaly in the overall male pay structure. That is, the specific male job class may be under or overpaid for its point value in comparison to other male job classes in the pay structure.

B. Comparison of Single, Female Job Class to Male Job Class Cluster

FIGURE 7



Source: Manitoba Pay Equity Bureau

In this example, thisfollowing data set has been used:

Gender-Dominatec Job Class	Point Value	Pay Rate ($/hr)
Female 1	400	$10.50
Male 4	380	11.00
Male 2	390	11.20
Male 6	420	11.10

The conjoint values for x and y for each job class are plotted on a graph. Straight lines are drawn from M4 to M6, M6 to M2 and M2 to M4. Straight lines are then drawn from the conjoint values at M2, M4 and M6 intersecting the midpoints of the lines directly opposite each conjoint value. The point where these three lines intersect may be used as the value for male comparability. The values for this point are 396.6 for "x" and $11.10 for "y". Therefore, the adjusted pay rate for the female job class with 400 points would be:

$$\frac{x \text{ (pay rate female job class)}}{400} = \frac{11.10}{396.6}$$

$$x \text{ (pay rate female job class)} = \$11.19$$

The adjusted wage rate could be determined mathematically without graphing in the following manner. The average of the point values (x) and the pay rates (y) of the male job classes M4, M2 and M6 can be calculated and used as a reference from which to relate directly to the female-dominated class. In this case, an average of the points for the male classes is 396.6 and the average pay rate is $11.10. These averages can be used to establish a pay rate of $11.19 for the female class F1.

Averages: Point value - $\frac{380 + 390 + 420}{} = \frac{1190}{3} = 396.6$

Pay rate - $\frac{11.10 + 11.20 + 11.00}{} = \frac{33.3}{3} = 11.10$

$$\frac{\text{Comparable female pay rate}}{\text{female point value}} = \frac{\text{average male pay rate}}{\text{average male point value}}$$

$$\frac{x}{400} = \frac{\$11.10}{396.6}$$

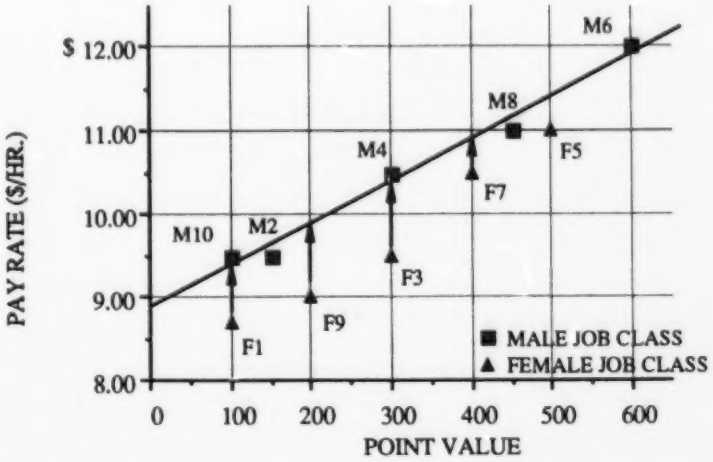
x (female pay rate) = $11.19

In contrast to the previous techniques of comparisons of single job classes, this method provides:

- Comparison of male and female job classes which are not identical in value; and
- Greater reliability since the comparison is to more than one male class. This reduces the probability of a female job class being adjusted to a male rate which is an anomaly in an organization.

C. Adjusting Female-Dominated Job Classes to Wage Regression Line for Males

FIGURE 8



Source: Manitoba Pay Equity Bureau

In this example, the data set outlined in Section 1, page 3 has been used. The first step in this technique is determining the regression line

for males using the method of Least Squares. The female-dominated job classes are then adjusted upward to the male regression line. For example, when female class 1 is adjusted to the male regression line, the pay rate increases from $8.70 to $9.39 per hour.

Similarly, the pay rates for classes F3, F5, F7 and F9 can be determined by projection to the male regression line. The adjusted rates would be:

Class F3 at 300 points: from $9.50 to $10.40/hour
Class F5 at 500 points: from $11.00 to $11.41/hour
Class F7 at 400 points: from $10.50 to $10.90/hour
Class F9 at 200 points: from $9.00 to $9.89/hour.

In place of graphing the evaluated job classes to determine adjusted pay rates for female job classes, the new pay rates can be determined statistically using the formula $y = a + bx$. The slope of the line is "b" and "a" is the "y" intercept.

With the slope and the "y" intercept established, the value for "x" can be substituted with the female job class point value and the corresponding value for "y" or pay rate can be determined. The adjusted rate to be paid to the female job classes can be calculated in relation to the male regression line.

For example, the pay rate for class F5 would be:

$y = a + bx$
b (slope) = .005057
a (y intercept) = 8.8815
x (point value F5) = 100
y (adjusted pay rate) = 8.8815 + (.005057) 100
= $9.39

For more detail on this method, refer to Appendix B.

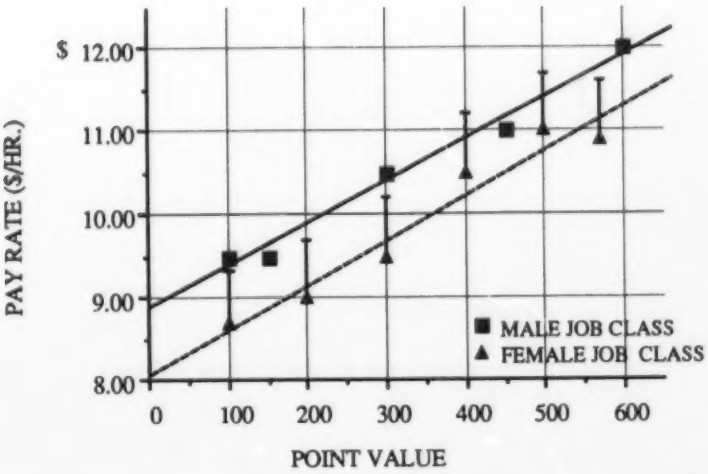
As compared to the other two previous techniques of comparison, this method has the following distinctive features:

- There are no direct one on one comparisons of female to male-dominated job classes. This reduces the potential for workers in comparable male job classes to develop an adversarial position towards pay equity.

- The pay structure for the female job classes is adjusted to be in alignment with the overall pay structure for the male job classes. This provides more consistency in the adjustments to the female job classes.

D. Adjusting Female-Dominated Job Classes Without Altering Female-to-Female Job Class Relationships

FIGURE 9



Source: Manitoba Pay Equity Bureau

This method of adjusting female pay inequities protects the existing interrelationship between female job classes. However, this technique should be examined carefully as it may only partially correct the pay discrepancies between comparable male and female job classes.

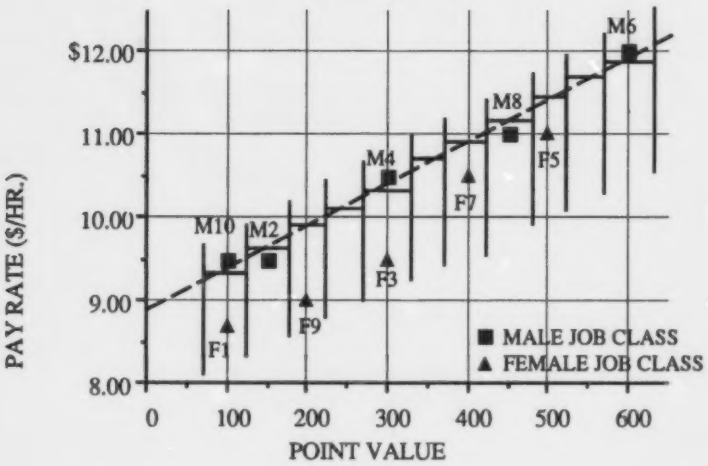
If the slopes of the male and female regression lines are similar, the distance between the two lines could be applied as the standard adjustment for increasing the female-dominated job classes. In the graph above, the pay rates of all female job classes have been increased by

$0.60 per hour.

If this method is considered, additional analysis is necessary after the designated adjustments to ensure that the increases in female job class pay rates are within the legislated parameters of the Act.

E. Adjusting Female-Dominated Job Classes by Banding or Segmenting

FIGURE 10



Source: Manitoba Pay Equity Bureau

The data set outlined in Section 1, page 3 has been used in this example.

The first step in this technique is the plotting of the pay rates for the evaluated male classes. The wage regression line is then determined for the males. This wage curve provides the basis for pay rates and bands. The distance between each band is based on factors such as:

- the number of desirable pay grades in a salary structure;

- the encompassing of all job classes considered similar enough in value to receive the same level of pay; and
- the establishing of a reasonable difference in pay rates between job classes in one band and job classes in the next higher band.

In the example given above, the width of each band has been set at 50 points. The rate per hour for all job classes and the width of each band have been determined so as to follow the male regression line. In the pay equity process, the bands and incremental pay rate adjustments can be negotiated. In this example, the bands start at 70 and increase every 50 points. The pay rates start at $9.30 and increase 26 cents per pay band to a maximum of $11.90.

Band	Point Values	Pay Rate
1	71-120	$9.30/hr
2	121-170	9.56
3	171-220	9.82
4	221-270	10.08
5	271-320	10.34
6	321-370	10.60
7	371-420	10.86
8	421-470	11.12
9	471-520	11.38
10	521-570	11.64
11	571-620	11.90

As an example of the application of this technique, all female job classes, in band 1 with point values of 71 to 120 would be adjusted to a pay rate of $9.30 per hour.

Therefore, female class 1 would be adjusted from $8.70 per hour to $9.30 per hour, class F9 from $9.00 per hour to $9.82 per hour, class F3 from $9.50 per hour to $10.34 per hour, class F7 from $10.50 per hour to $10.86 per hour, and class F5 from $11.00 per hour to $11.38 per hour.

1. Calculation of Cost Based on Percentage of Total Payroll

According to section 7 and subsection 3 of the Act, an employer is not obligated to implement pay equity wage adjustments in any 12-month period in an amount in excess of 1% of the total payroll for the preceding 12-month period; for a total period of 4 consecutive 12-month periods.

It is possible that there will be fluctuation in an organization's total payroll from one year to the next. Addition of the previous year's pay equity wage adjustment will contribute to this fluctuation. In general, however, parties should be aware of the total payroll costs for the previous year and be aware of the amount available for pay equity wage adjustments.

2. Calculation of Cost Based on Wage Adjustment to Female-Dominated Job Classes

Costs can be calculated based on the designated adjustments for all female-dominated job classes and the total adjustments for all incumbents in these classes.

In the following table, the amount of adjustment has been calculated for each of the female classes F1, F3, F5, F7 and F9. The amount for each class has then been multiplied by the number of incumbents in each class to arrive at the total amount of adjustment. For example class F1 has 10 incumbents and a designated adjustment of $0.80/hour with wages after adjustment for this class totalling $95.00. The total amount necessary for this class would be $0.80 X 10 = $8.00/hour. Total payroll for all female classes for all employees on an hourly basis after pay equity adjustments is $1070.72. A projection of total costs can be calculated by subtracting total present payroll per hour from adjusted total payroll per hour. To calculate this amount on a percentage basis, the adjustment of $41.22 is then divided by present total payroll of $1029.50 to arrive at 4.0%.

It should be noted in this case, it is assumed that all employees are working the same number of hours. In most organizations, cost projections would have been calculated taking total hours into account.

Calculation Of Cost Based On Wage Adjustments To Female-Dominated Job Classes

Job Class	Number of Incumbents			Present Pay Rate ($/Hr)	Pay Rate Adjustment ($/Hr)	Pay Rate after Adjustment ($/Hr)	Total Wages ($/Hr.)	
	Male	Female	Total				Before Adjustment	After Adjustment
Female 1	2	8	10	$8.70	$0.80	$9.50	$87.00	$95.00
Female 3	1	11	12	9.50	1.00	10.50	114.00	126.00
Female 5	0	6	6	11.00	0.33	11.33	66.00	67.98
Female 7	2	6	8	10.50	0.33	10.83	84.00	86.64
Female 9	2	18	20	9.00	0.83	9.83	180.00	196.00
Male 2	7	1	8	9.50	--	9.50	76.00	76.00
Male 4	5	0	5	10.50	--	10.50	52.50	52.50
Male 6	4	0	4	12.00	--	48.00	48.00	48.00
Male 8	9	3	12	11.00	--	11.00	132.00	132.00
Male 10	16	4	20	9.50	--	9.50	190.00	190.00
TOTAL	48	57	105				$1,029.50	$1,070.72

$$\text{Cost} = \frac{1070.72 - 1029.50}{1029.50} = 4.0\%$$

Creating A Graphic Perspective Of Male And Female-Dominated Job Classes

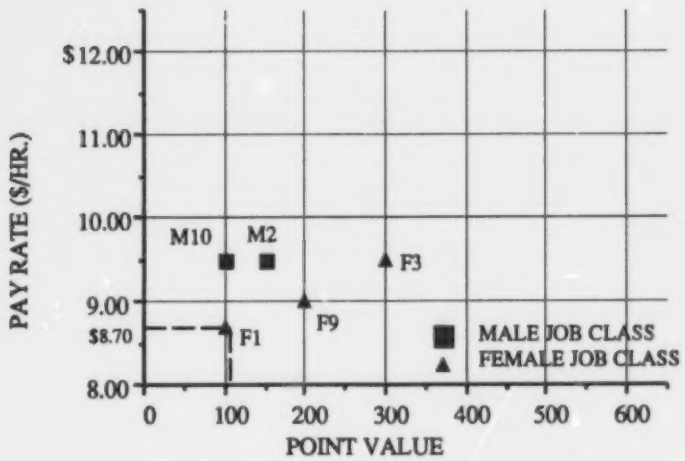
The points for each of the evaluated job classes can be graphed to produce a scattergram by:

1. Establishing an "x" axis (horizontal) with a range which encompasses all of the numerical point values from the evaluation process;
2. Establishing a "y" axis (vertical) with a range which encompasses all of the pay rates for all evaluated job classes; and
3. Plotting each job class by using the conjoint value of "x" and "y" (the numerical point value on the "x" axis and the corresponding pay rate on the "y" axis).

The following example presents the graphing of 3 female-dominated and 2 male-dominated job classes.

Gender-Dominated Job Class	Point Values ("x" axis)	Pay Rate ("y" axis)
Female 1 (F1)	100	$8.70/hr
Female 3 (F3)	300	9.50
Female 9 (F9)	200	9.00
Male 2 (M2)	150	9.50
Male 10 (M10)	100	9.50

FIGURE 1-A



Source: Manitoba Pay Equity Bureau

Common Statistical Methods For Pay Equity Implementation

This appendix presents a brief overview of some of the statistical methods that may be used in a pay equity exercise. It was prepared by the Manitoba Bureau of Statistics, a resource for organizations requiring assistance on statistical methodology.

The discussion presents a number of ways of describing the data set under consideration, followed by a linear regression analysis. The methods presented are worked out using the data set in Section 1, page 3.

It should be noted that the appropriate method to be used for each organization will depend on the characteristics of the data for that particular organization.

What Is Statistics?

1. Statistics is concerned with the development and application of methods and techniques for collecting, analyzing and interpreting quantitative data in such a way that the reliability of conclusions based on the data may be evaluated objectively by means of probability statements.

Descriptive Statistics reduce a large amount of data to a manageable, usable level.

A. Descriptive measures
- i) central tendency (average)
- ii) dispersion

B. Frequency distributions
- i) frequency tables
- ii) graphs (pie charts, bar charts, histograms)

Analytical Statistics test a statistical hypothesis or explore relationships among characteristics with an aim to explain rather than describe. The tests are made in a probabilistic sense.

2. Calculation of Measures of Central Tendency

The most frequently used measure of central tendency is the mean. Three types of means are presented (arithmetic, geometric and harmonic) although only the arithmetic mean, which is commonly known as the average is used under usual circumstances.

The **arithmetic mean** is defined as the sum of the data values divided by the number of values.

$$Y = \frac{\Sigma Y}{n} = \frac{9.50 + 9.50 + 10.50 + 11.00 + 12.00}{5}$$

$$= \frac{52.50}{5} = \$10.50$$

The **geometric mean** is defined as the nth root of the product of the data values.

$$Yg = \sqrt[n]{\pi Y} = \sqrt[5]{9.5 \times 9.5 \times 10.5 \times 11 \times 12}$$

$$= \sqrt[5]{125{,}086.5} = \$10.458$$

The **harmonic mean** is defined as the number of data values divided by the sum of the reciprocals of the data values.

$$Yh = \frac{n}{\Sigma \frac{1}{Y}} = \frac{5}{\frac{1}{9.5} + \frac{1}{9.5} + \frac{1}{10.5} + \frac{1}{11} + \frac{1}{12}}$$

$$= \frac{5}{0.48001} = \$10.417$$

The geometric and harmonic means can be difficult to calculate for large data sets but are not as sensitive to extreme data values as is the arithmetic mean.

Another measure of central tendency is the **median**, which is defined as the value such that 50% of the data values are less than the median and 50% are greater.

$$\$9.50 \quad 9.50 \quad \underset{\text{median}}{10.50} \quad 11.00 \quad 12.00$$

The final measure of central tendency to be considered is the **mode**, which is the data value that occurs most frequently. For our data set, the mode is $9.50.

3. Calculation of Measures and Dispersion

Measures of dispersion, which indicate the spread of the data values include the:

Range - the difference between the highest and lowest values

$$\$12.00 - \$9.50 = \$2.50$$

Mean Deviation - the arithmetic mean of the differences between the data values and the average, with the sign ignored.

$$\frac{1}{n}\Sigma |Y_i - \bar{Y}| = \frac{1}{5} (1.00 + 1.00 + 0 + 0.50 + 1.50)$$

$$= \frac{4.00}{5} = \$0.80$$

Variance - the "average" of the square of the difference between the data values and the average.

$$s^2 = \frac{1}{n-1} \Sigma(Y_i - \bar{Y})^2 = \frac{(1.00 + 1.00 + 0 + 0.50 + 1.50)}{n-1}$$

$$= \frac{4.50}{4} = 1.125$$

Standard Deviation - square root of the variance.

$$s = \sqrt{1.125} = \$1.06066$$

Coefficient of Variation - ratio of the standard deviation divided by the average.

$$C.V. = \frac{s}{\bar{Y}} = \frac{1.06066}{10.5} = 0.101015$$

Why calculate the variance?

If one is willing to make assumptions about the data e.g. normal distribution, then the variance allows us to calculate the probabilities of certain occurrences.

So far we have been concerned with a single measurement made on each element of the sample. We now consider the case for two measure-

ments on each element of the sample e.g. points and pay rate of a position. The two measurements are denoted X (points) and Y (pay rate) and we want to examine the relationship between them.

X (Points)	150	300	600	450	100
Y (Pay Rate)	$9.50	$10.50	$12.00	$11.00	$9.50
Ratio ($/point)	0.063	0.035	0.02	0.024	0.095

means Points 320 Wage $10.50

Ratio $\frac{0.237}{5}$ = $0.0475 per point

ratio of means $\frac{\$10.50}{320}$ = $0.032812 per point

Calculating the above ratio assumes that all of the pay rate is accounted for by the points and does not allow for an underlying pay rate that may be paid regardless of the number of points.

4. Calculation of a Linear Regression Line

This statistical procedure allows one to calculate wage regression lines for male and female-dominated job classes.

Assumptions

1. Model is of the form $Y_i = A + BX_i + e_i$
2. X is measured without error.
3. $e_i \sim N(0,\sigma^2)$ and all pairs e_i, e_j are independent.

The regression line $Y = A + BX$ is estimated by the equation

$$\hat{Y} = a + bX.$$

The method of **Least Squares** fits $\hat{Y} = a + bX$ to the data so as to minimize

$\Sigma(Y_i - \hat{Y}_i)^2$ the sums of squares for error denoted SS(E).

Minimizing $SS(E) = \Sigma[Y_i - (a + bX_i)]^2$ is done by setting

$$a = \bar{Y} - b\bar{X} \quad \text{and} \quad b = \frac{SS(XY)}{SS(X)} \quad \text{where}$$

$$SS(XY) = \Sigma (X_i - \bar{X})(Y_i - \bar{Y}) \quad \text{and} \quad SS(X) = \Sigma(X_i - \bar{X})^2$$

Using the job classes and points values in Section 1, page 3 calculations determining the regression line are shown below.

Class	Points	Wage	$X-\bar{X}$	$(X-\bar{X})^2$	$Y-\bar{Y}$	$(Y-\bar{Y})^2$	$(X-\bar{X})(Y-\bar{Y})$
M2	150	$ 9.50	-170	28,900	-1.00	1.00	170
M4	300	10.50	- 20	400	0	0	0
M6	600	12.00	280	78,400	1.50	2.25	420
M8	450	11.00	130	16,900	.50	.25	65
M10	100	9.50	-220	48,400	-1.00	1.00	220
	1600	52.50	0	173,000	0	4.50	875

$\bar{X} = 320 \qquad \bar{Y} = \$10.50$

$$b = \frac{SS(XY)}{SS(X)} = \frac{875}{173{,}000} = \$0.0050578 \text{ per point}$$

$$a = \bar{Y} - b\bar{X} = \$10.50 - \$0.0050578 \times 320 = \$8.8815$$

Therefore we have estimated that the relationship between points and hourly wages for the male positions is:

Wage = $8.8815 + $0.0050578 x Points.

Using this equation, the predicted wages for the five male positions are

Points	Predicted Wage ($\hat{Y}$)	$Y_i - \hat{Y}$	$(Y_i - \hat{Y})^2$
150	9.640	-0.140	0.019648
300	10.399	0.101	0.010233
600	11.916	0.084	0.007025
450	11.158	-0.158	0.024810
100	9.387	0.113	0.012706
	52.500	0	0.074422

$$\text{Variance of } \hat{Y} = \frac{1}{n-2} \Sigma(Y_i - \hat{Y})^2 = \frac{0.074422}{3} = 0.024807$$

Another way to calculate the variance of $\hat{Y}$ is:

$$s^2 = \frac{SS(Y) - b\,SS(XY)}{n-2} = \frac{4.50 - 0.0050578 \times 875}{3}$$

$$= \frac{0.074422}{3} = 0.024807$$

The strength of the linear relationship between X and Y is called the **Coefficient of Determination** and defined as:

$$R^2 = \frac{SS(Y) - SS(E)}{SS(Y)} = \frac{4.50 - 0.074422}{4.50} = 0.98346$$

The correlation coefficient, R is defined as:

$$R = \frac{SS(XY)}{\sqrt{SS(X) \times SS(Y)}} = \frac{875}{\sqrt{173{,}000 \times 4.50}} = \frac{875}{\sqrt{778{,}500}}$$

$$= \frac{875}{882.3265} = 0.991696$$

$R^2 = 0.98346$

This implies that 98.3% of the variation in the wages of the male positions is explained by the variation in the point ratings for the positions.

Similar calculations for the female position data result in:

Class	Points	Wage	$X-\bar{X}$	$(X-\bar{X})^2$	$Y-\bar{Y}$	$(Y-\bar{Y})^2$	$(X-\bar{X})(Y-\bar{Y})$
F1	100	$8.70	-200	40,000	-1.04	1.0816	208
F3	300	9.50	0	0	- .24	.0576	0
F5	500	11.00	200	40,000	1.26	1.5876	252
F7	400	10.50	100	10,000	.76	.5776	76
F9	200	9.00	-100	10,000	-.74	.5476	74
	1500	48.70	0	100,000	0	3.8520	610

$\bar{X} = 300 \quad \bar{Y} = \$9.74$

$$b = \frac{610}{100,000} = \$0.00610 \text{ per point}$$

$a = \bar{Y} - b\bar{X} = 9.74 - 0.00610 \times 300 = \$7.91$

and the estimated regression line of the female positions is

Wage = $7.91 + $0.00610 x Points

Points	Predicted Wage ($\hat{Y}$)	$Y_i - \hat{Y}$	$(Y_i - \hat{Y})^2$
100	$ 8.52	$0.18	0.0324
300	9.74	-0.24	0.0576
500	10.96	0.04	0.0016
400	10.35	0.15	0.0225
200	9.13	-0.13	0.0169
		0	0.1310

$\bar{X} = 300 \quad \bar{Y} = \$9.74$

$$s^2 = \frac{0.1310}{3} = \$0.0436$$

or $$s^2 = \frac{3.852 - 0.0061 \times 610}{3} = \$0.0436$$

and the Coefficient of Determination is

$$R^2 = \frac{610^2}{100{,}000 \times 3.852} = 0.965992$$

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Affirmative Action: A program that aims to remedy the effects of discriminatory hiring and training practices, and to achieve equitable employment opportunities for designated target groups including women, natives, visible minorities and the physically disabled.

Arbitration: The process by which a board or arbitrator, acting under the authority of legislation, a collective agreement or mutual consent of both parties to a dispute, hears both sides of a controversy and issues an award, which is ordinarily binding on both parties.

Award, Decision or Order: The final decision of an arbitrator, binding on both parties to the dispute.

Bargaining Agent: The exclusive representative of a group of workers or employers in the process of collective bargaining.

Bargain in Good Faith: The requirement that two parties meet and confer with minds open to persuasion with a view to reaching agreement.

Bargaining Unit: A group of employees recognized by the employer and certified by a labour board for the purpose of collective bargaining.

Benchmark Jobs: A representative sampling of jobs covering the spectrum of jobs in an organization. Benchmark jobs can be used as reference points in the design and application of a job evaluation system.

Collective bargaining: Method of determining wages, hours and other conditions of employment through direct negotiations between the union and employer.

Comparable worth: The principle that jobs can be compared even though they may be dissimilar in nature but equal or equivalent in terms of skill, effort, responsibility and working conditions. This term is often used in the United States and is synonymous with pay equity in Canada.

Compensation Policy: The standards which an organization uses in making wage and salary compensation decisions.

Complaint-based Legislation: Legislation which requires an employee(s) to identify an alleged inequity and file a complaint. The complaint is then reviewed and investigated and either confirmed or denied. A confirmed complaint requires correction.

Effort: The measurement of mental and physical application required in a job to adequately perform the assigned tasks.

Employee Representative: A representative of non-unionized employees.

Equal Pay for Equal (or Substantially the Same) Work: The principle that a woman doing the same or substantially the same work as a man in an establishment should receive equal pay.

Equal Pay for Work of Equal Value: The principle of paying equal pay for different jobs in an organization which are determined to contribute the same or comparable value to that organization. A principle which will eliminate gender-based wage discrimination. The terms pay equity or comparable worth can also be used to describe this concept.

Establishment: A term often used in pay equity legislation to define the "workplace". Manitoba's legislation requires comparison of jobs within an establishment, not outside the establishment.

Factor: A basic component or part of a job evaluation plan which is used to measure characteristics of a job. For pay equity purposes, four factors are measured. They are skill, effort, responsibility and working conditions.

Factor Comparison: A method of job evaluation which compares jobs by making judgments about which jobs contain more of certain compensable factors than others.

Female-dominated Job Class: For pay equity purposes, a job class with 10 or more employees, where 70% or more of the people in the job class are women.

Gender-bias: Any practice or program which incorporates discrimination between men and women, either directly or indirectly.

Gender-dominance: A job class which is occupied predominantly by women, or predominantly by men. According to Manitoba's legislation, a class is gender-dominated if it has 10 or more incumbents, with 70% or more of the same gender.

Gender-neutral: Any practice or program which does not incorporate or allow gender-discrimination between men and women, either directly or indirectly.

Implementation: For pay equity purposes, the carrying out of The Pay Equity Act with implementation complete after wage adjustments have been made.

Increment: The difference between two consecutive pay grades in a wage structure. For example, if pay grade one pays $5.00 per hour and pay grade two pays $5.17 per hour, 17 cents is the increment.

Industry-wide Bargaining: Collective bargaining that takes place on an industry-wide basis; terms and conditions of employment agreed upon cover all or a major portion of the organized employees in the industry.

Job Analysis: A systematic collection of the various tasks involved in a job or job class and the minimum requirements needed to perform the job adequately. The process of information gathering.

Job Class: "Class" or "class of positions" means a group of positions involving duties and responsibilities so similar that the same or like qualifications may reasonably be required for, and the same schedule or grade of pay can be reasonably applied to, all positions in the group.

Job Classification: A type of job evaluation whereby the total job is evaluated and is then slotted into a pay grade that has been defined. Each job is placed into the grade where the grade description most closely fits the particular job being evaluated.

Job Description: A written description of the requirements of the job including job duties, tasks, responsibilities and scope.

Job Evaluation: The process of comparing the value of jobs in order to determine the position of one job in relation to another.

Job Evaluation System: For purposes of pay equity, a single, gender-neutral evaluation system capable of measuring skill, effort, responsibility and working conditions.

Job Ghettoization: The concentration of women into low-paying, low status jobs.

Job Specifications: Identification of the amount, level or type of skill, effort, responsibility and working conditions required to perform the duties and responsibilities listed on the job description.

Labour-management Committee: Any committee having representation from both management and labour. They may discuss such topics as safety and health, training, or job evaluation.

Male-dominated Job Class: For pay equity purposes, a job class with 10 or more employees, where 70% or more of the incumbents in the job class are men.

Manitoba Labour Board: The board, provided for under The Labour Relations Act of Manitoba, which is responsible for certification of trade unions, the inclusion of dispute-settling provisions in collective agreements and investigation of complaints of bad faith in collective bargaining.

Method of Least Squares: The statistical procedure for computing a line of regression by finding the best fitting straight line for a set of points.

Non-traditional Jobs: Occupations which have generally been filled by either women or men to the exclusion of the other.

Occupational Segregation of Women: The concentration of women into a narrow range of occupations, primarily clerical, sales, service and health care.

Pay Equity: The concept of equal pay for work of equal value, based primarily on the relative value of work performed, irrespective of the gender of employees. Manitoba requires that no employer covered by The Pay Equity Act shall establish or maintain a difference between the wages paid to male and female employees, employed by that employer, who are performing work of equal or comparable value.

Point-rating or Point Factor: A method of job evaluation in which a rating scale is constructed for each factor, each factor receives a numerical score, scores are totaled and a job value is established.

Policy Capturing: A method of job evaluation which relies heavily on statistical procedures for capturing current pay policies of a company and identifying wage discrimination based on gender. Factors and weightings can then be adjusted to remove the identified wage discrimination.

Pro-active Pay Equity Legislation: Requires employers, in co-operation with employee representatives, to initiate an audit of their pay practice within specific timelines and to identify and correct any pay equities between male and female-dominated job classes of equal or comparable value.

Ranking: A method of job evaluation in which jobs in the organization are ranked in order on the basis of their importance to the organization or general difficulty.

Ratification: Formal approval of a newly negotiated agreement by vote of the union members affected, as well as by employers or employer associations.

Rating Committee: A committee established to objectively determine the value of jobs by applying the job evaluation system to the job content information.

Regression Analysis: Used to test for the impact of an independent variable on the dependent variable while statistically controlling for the effects of other independent variables. For pay equity purposes, it is used to estimate the relationship between point values of evaluated gender-dominated jobs and the pay rates.

Responsibility: Aspects such as accountability or decision making components of the job. Often measures consequence of responsibility such as cost factors, human relations, supervision.

Salary Range: The full progression of increments from starting rate to maximum for a particular job, job class, or pay scale.

Salary or Pay Line: For pay equity purposes, the determination of the female or male salary structure in a workplace. The pay line identifies the general trend of an organization's pay practice as applied to male and female-dominated job classes. Can be determined statistically by Method of Least Squares to produce a wage regression line.

Scattergram or Scatter Diagram: A diagram or graph, pictorially displaying the relative values of jobs or job classes and their respective wage rates.

Skill: The level of knowledge or ability required to perform the tasks of the job. Often measured in terms of education, experience and training.

Sub-factor: A further breakdown of identified factors. In job evaluation plans, a factor such as skill could have sub-factors such as education or on-the-job training; effort could be broken down into sub-factors such as physical effort and mental effort.

Systemic Discrimination: Discrimination in employment policies or practices that adversely affects certain groups even though the discrimination may not be overt or intended.

Systematic Undervaluation: A consistent application of bias by either application or design.

Under Representation: Where the number of women participating in a specific type of job is lower than the representation in the general population.

Wages: "Wages" means any form of remuneration payable or benefit provided by an employer for work performed by an individual. "Wage rate" has a corresponding meaning.

Wage Gap: The difference between the average wage paid to men and women.

Wage Structure: A systematic and logical arrangement of the compensation of an organization, usually called pay grades.

Weighting: The process of allocating a higher emphasis to one factor than another, so that the factors considered to be of relatively greater importance to an organization, assume greater importance.

Working Conditions: Encompasses the environmental surroundings and also the conditions under which the tasks are performed. These conditions could be either physical or psychological.